

# Industrial Technologies Program

## Upgrading Low-Grade Ore by In-Pit Crushing and Cobbing

### In-Pit Crushing and Cobbing for Grinding Ore Products Will Increase Mill Productivity

Crushing and grinding processes for mineral products are extremely energy-intensive, consuming about 39 percent of the total energy consumed in U.S. processing plants. As ore bodies age, weight recovery decreases, increasing the amount of energy consumed per ton. Research on in-pit crushing and cobbing conducted fifteen years ago revealed positive improvements in weight recovery and mill concentrate production. Due to these positive results, a larger 500,000 long-ton test was conducted five years later at Hibbing Taconite. While the weight recovery benefits were once again realized, a 10 percent improvement in mill productivity identified earlier was not realized during this trial.

To address this challenge, mine engineers at Hibbing Taconite are developing an in-pit crushing and cobbing system with the capability of processing low-grade ore. Weight recovery of the pit-processed ore is predicted to increase from 21 to 31 percent. There are two focal points of the project: 1) optimization of the in-pit crusher system, and 2) optimization of grinding mill productivity. Optimizing the crusher system will allow optimal blasting to achieve the most efficient feed size, wear material life, and optimal crushing settings that yield the most efficient magnetic in-pit cobbing of the crushed product.

Optimization of grinding mill efficiency will evaluate current mill performance versus the percent of upgraded ore in the mill feed. The project will focus on achieving the 10 percent improvement in mill productivity that was realized in the original study.

Iron ore is particularly energy-intensive because the ore must be ground very finely to liberate the iron. Because the U.S. iron ore and steel industry is struggling to survive in a global economy, mines must reduce costs to stay in business. For these reasons the U.S. iron ore industry will be used as a test case for this new in-pit crushing and grinding system.

The proposed project will apply controlled crude ore blending, mill circuit material balances, and computer modeling analysis of the operating data to reach its goal.

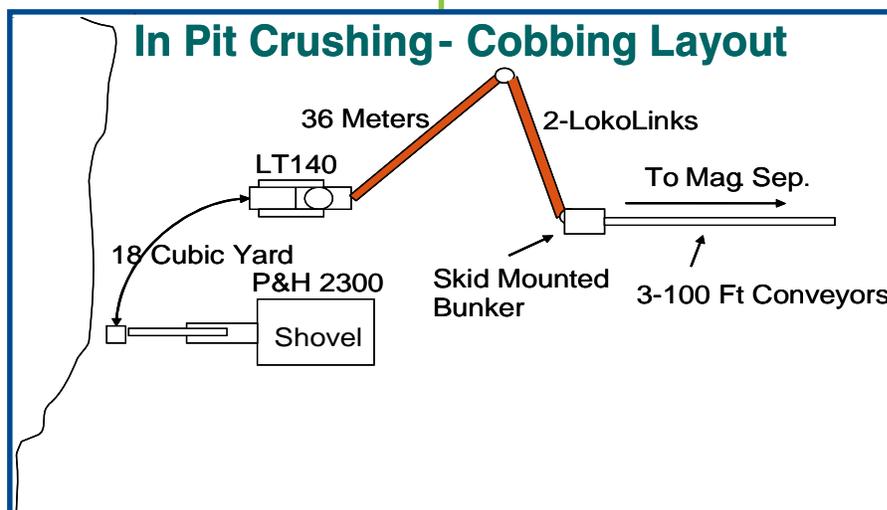


### Benefits for Our Industry and Our Nation

- Reduce net comminution energy by as much as 21%.
- Increase low-grade ore weight recovery by 48%.
- Produce a byproduct that is sellable to the aggregate industry with a 90% energy reduction required for its production.
- Convert ore reserves that are uneconomical to a proven economical resource.
- Reduce environmental waste.
- Lessen employee exposure to processing-related dust.

### Applications in Our Nation's Industry

In-pit crushing of ore has the potential for application in all mining processing operations. Information gained from this project will be available to all iron ore and non-iron ore mines.



Loading From Face to Mobile Jaw Crusher and Hinged Belt

## Project Description

Objective: To lower energy costs of comminution (grinding) to produce ore pellets through the development of an in-pit crushing and cobbing system, and to utilize low-grade ore that would otherwise not be processed due to its poor economics.

The goals of this project are to reduce comminution energy by 21 percent, increase the low grade ore weight recovery by 48 percent, produce a byproduct that is sellable to the aggregate industry, and convert ore reserves that are now classified as uneconomical to proven economical resource.

The in-pit crushing and cobbing system will first test all possible parameters. Then, the system, its start-up and its shakedown will be implemented for smooth system operation. Crusher and cobbing efficiency will then be maximized through testing of various blends of upgraded low-grade ore. This testing will determine the maximum blend of upgraded low-grade ore that the mills can properly manage.

## Milestones

- Purchase in-pit crushing and cobbing system, and define initial planning, testing, settings, and required analysis techniques.
- Drill and blast per specifications, erect equipment and implement start-up and shakedown.
- Optimize in-pit crusher performance and magnetic cobber performance.
- Test various levels of upgraded low-grade ore in the feed to the concentrator.
- Optimize mill performance and identify the optimal mix of upgraded low-grade ore in the mill feed to obtain a 10 percent gain in mill productivity.

## Project Partners

Hibbing Taconite Company  
Hibbing, MN

Minnesota Department of Natural Resources  
St. Paul, MN

Coleraine Minerals Research Laboratory  
Duluth, MN

Metso Minerals NAM  
Tampere, Finland

Cleveland Cliffs  
Cleveland, OH

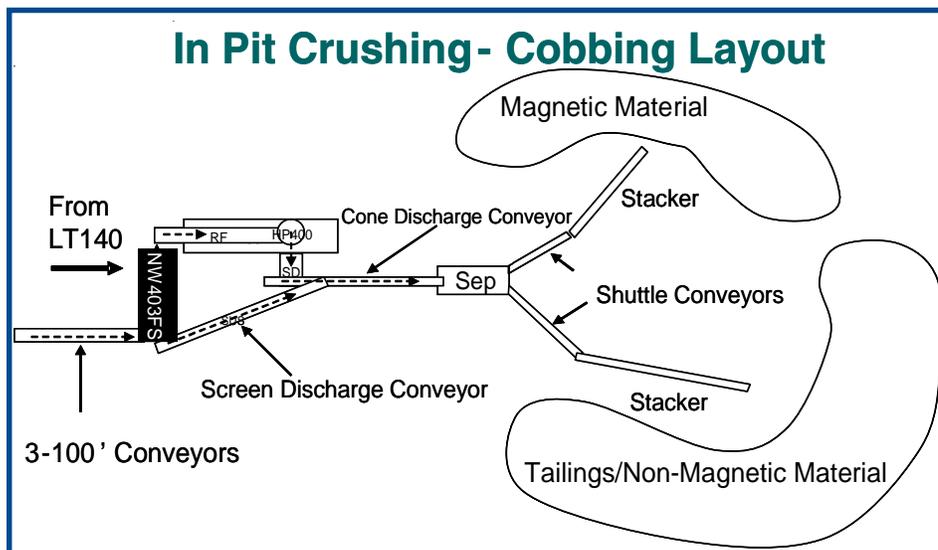
## A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy  
Energy Efficiency  
and Renewable Energy

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**From Hinged Belt to Cone Crusher and  
Magnetic Separator**